Field Phenotyping for drought tolerance

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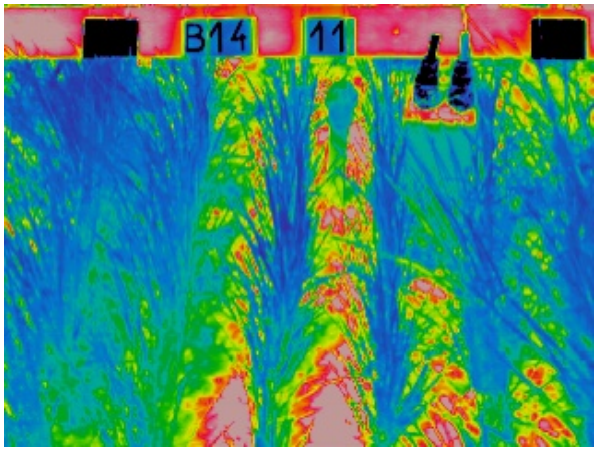
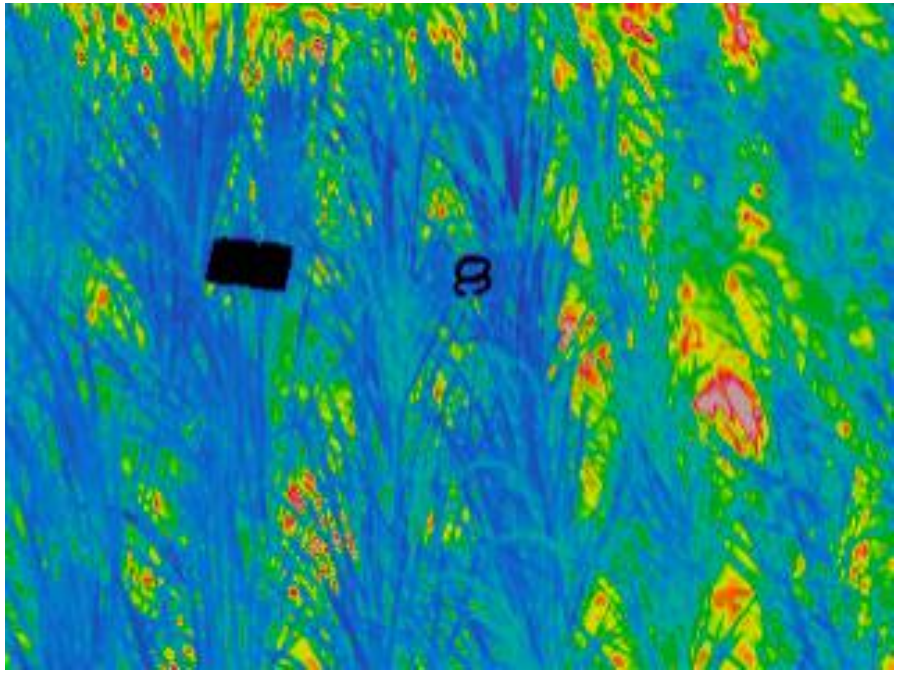
Field phenotyping for drought tolerance

- Based on Infra-red thermography.
  - Canopy temperature give an indication of the leaf surface cooling capacity by transpiration along environmental conditions
  - Could be use as a trait for phenotyping
    - (indirect evaluation of drought)
  - This trait depending of
    - Environmental conditions
      - Air temperature
      - Wind speed
      - Solar radiation
      - Evaporative demand (VPD)
    - Sol water conditions
      - Humidity / available
    - Plant characteristics
      - Surface of canopy
      - Plant Architecture
      - Water status management



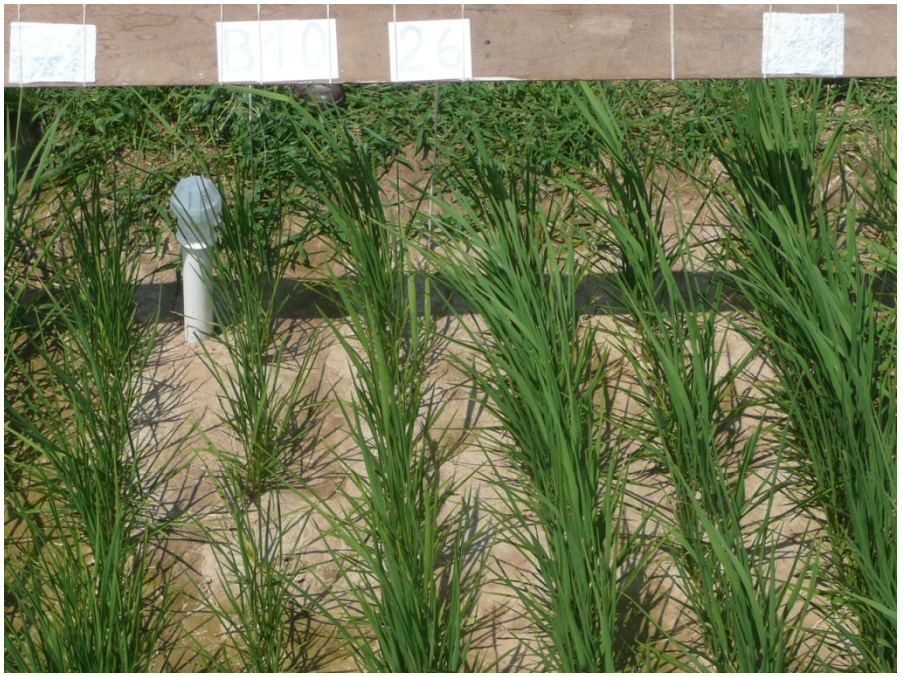
Pictures



Information

Bloc Identity

Line Identity



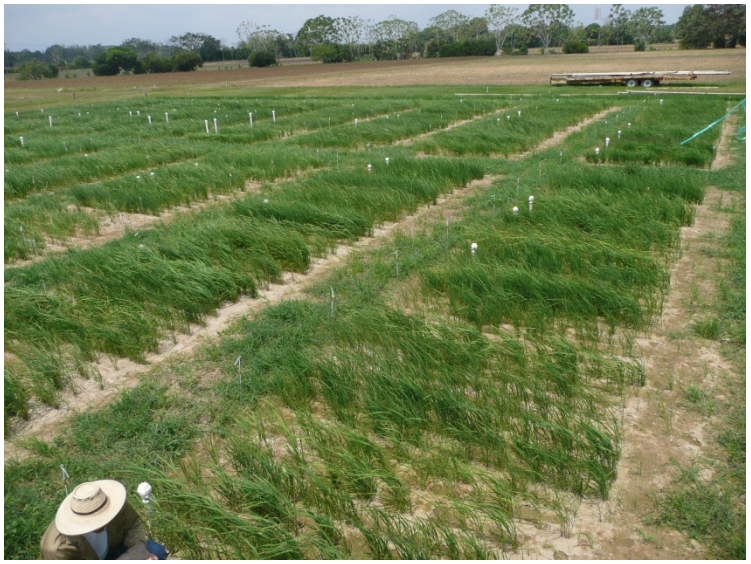
Control temperature

Aluminum paper

Soil humidity

Difficulties to solve

- Environmental conditions highly variable
- Quick plant reaction
  - Wind
  - Radiation
- Low equipment (camera and 1 technician)
  - Impossible to have one unique picture for the whole experiment
    - Helicopter
    - Drone
- Optimum 3-4 lines per image
  - 400 lines -> 100 -120 pictures
  - 1 image per minute
- Time for measurement
  - About 2-3 hours
  - Environmental stability



How to control the environment variability and compare results ?

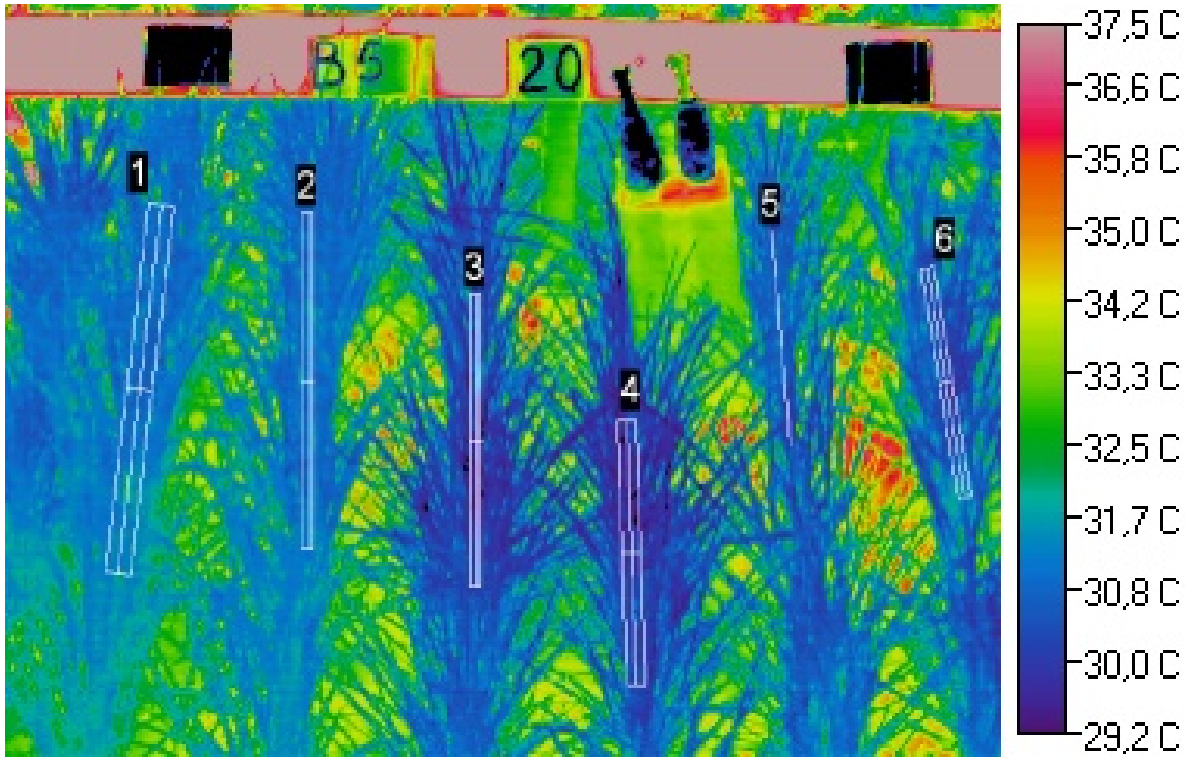
Using CWSI

- Quantifying the water stress with correlation between canopy temperature and evaporative demand
  - VPD
  - CWSI (Crop water stress index)

$$CWSI = \frac{(Ts - Ta) - (Ts - Ta)\min}{(Ts - Ta)\max - (Ts - Ta)\min}$$

- Need simultaneously measurement of the evaporative demand
  - Weather station
  - Psychrometer measurement
    - Humid and dry temperature

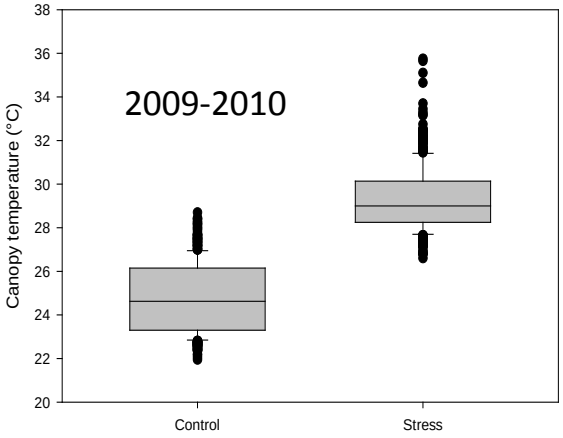
Results



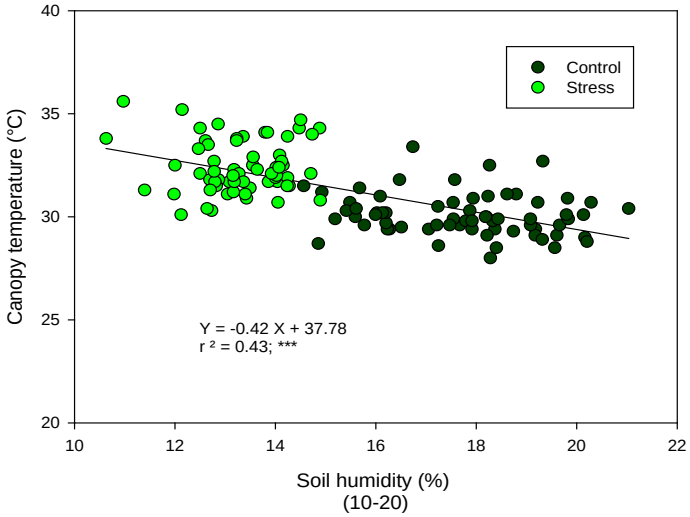
	Min. C	Max. C	Avg. C
Rectangle 1	30,5	32,8	31,1
Rectangle 2	30,4	32,3	31,0
Rectangle 3	29,1	32,5	30,2
Rectangle 4	28,8	31,4	30,0
Line 5	29,8	31,9	30,7
Rectangle 6	29,7	31,9	30,5

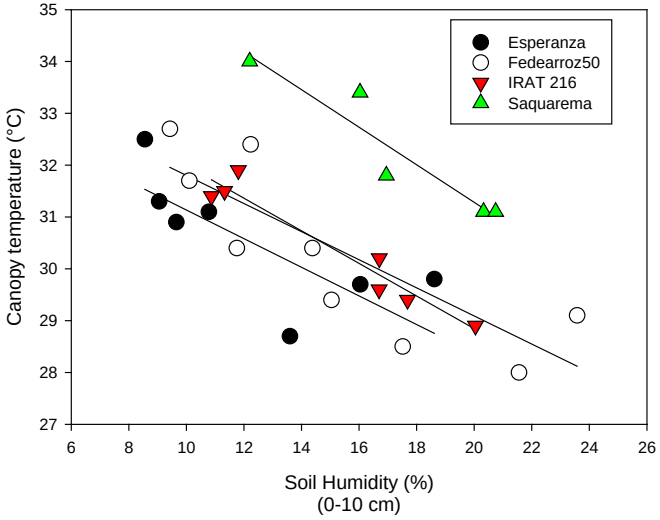
Line 19 : 31.05 °C
Line 20 : 30.10 °C
Line 21 : 30.60 °C

Results



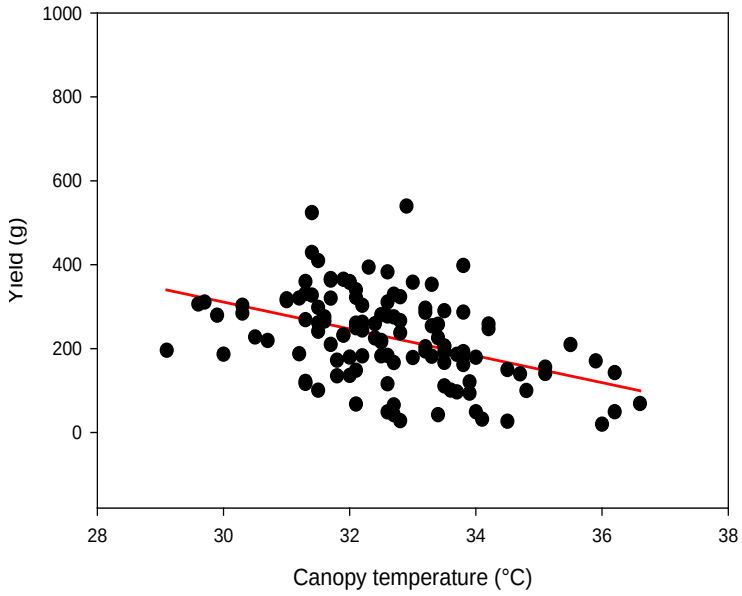
Stress 29.305 °C +/- 1.46
Control 24.771 °C +/- 1.62

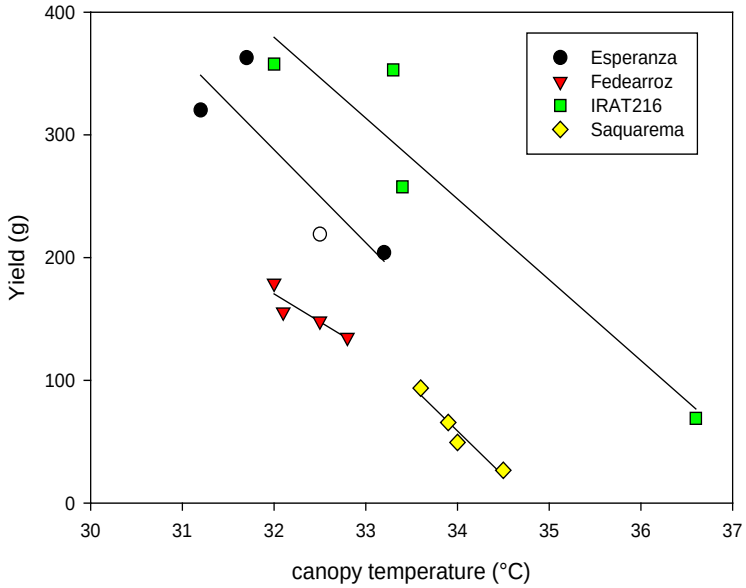




Direct relation between Soil humidity and Canopy temperature

Results

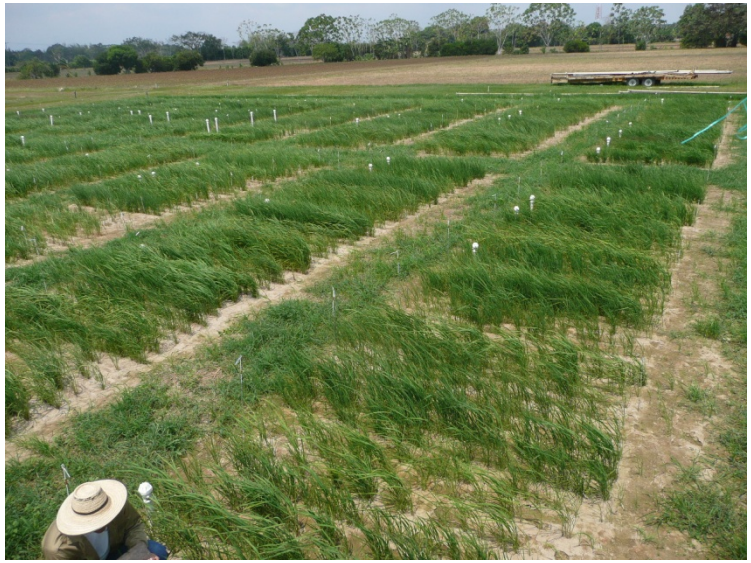




Direct relation between yield and Canopy temperature at Flowering stage

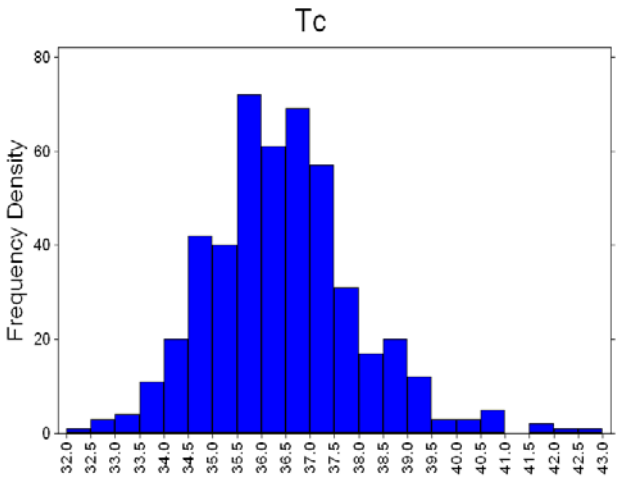
Phenotyping experiment

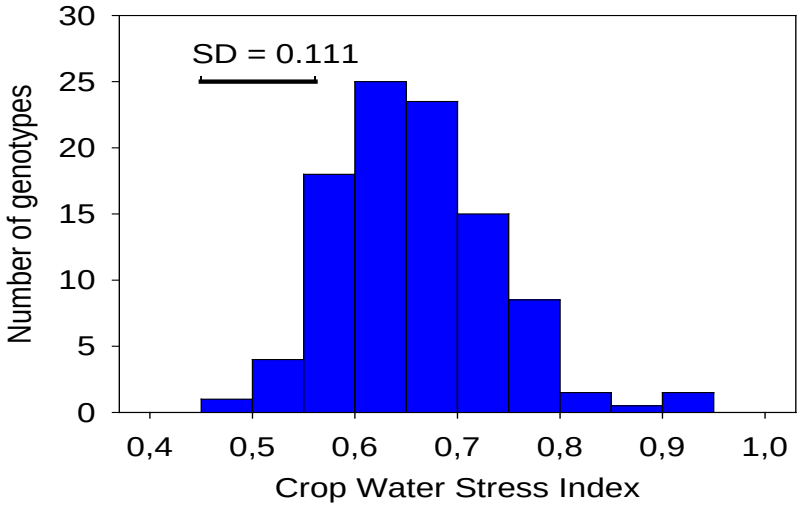
- Dry season
- Field experiment
  - Villavicencio station “Santa Rosa “(Colombia)
    - 240 varieties tested with 2 reps
    - Lines 3 meters
- Stress period 3 weeks (29/01-19/02/2010)
    - Vegetative stage

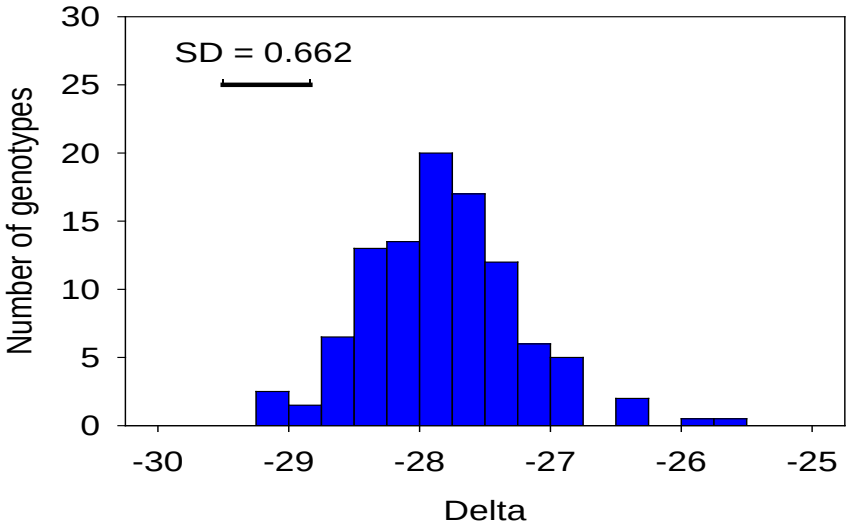


- Design
  - Alpha lattice 8 sub-Blocs with 2 replications
  - Complete randomization
  - 5 control varieties repeated
- Measurements
  - IR thermography once a week during the stress
  - Soil humidity
  - Microclimatic data
  - Carbon Isotopic Discrimination on control conditions

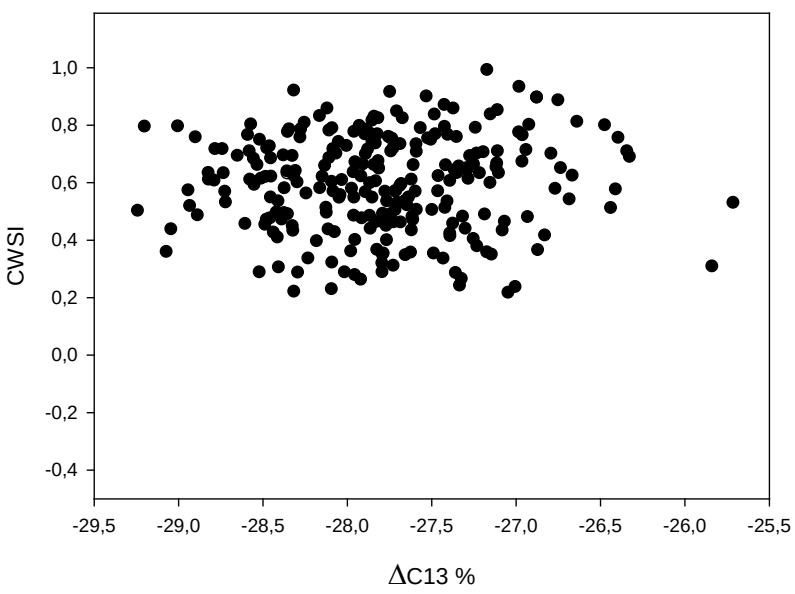
Temperature and WUE Diversity

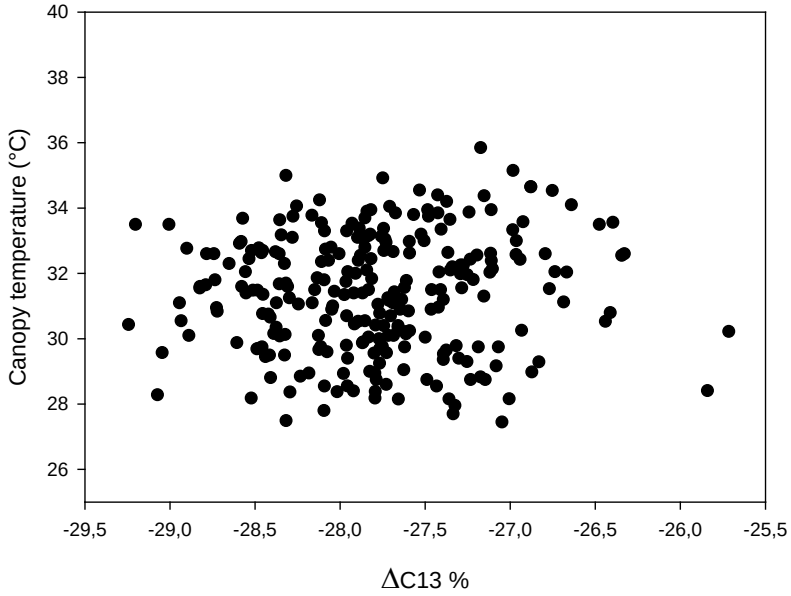






But

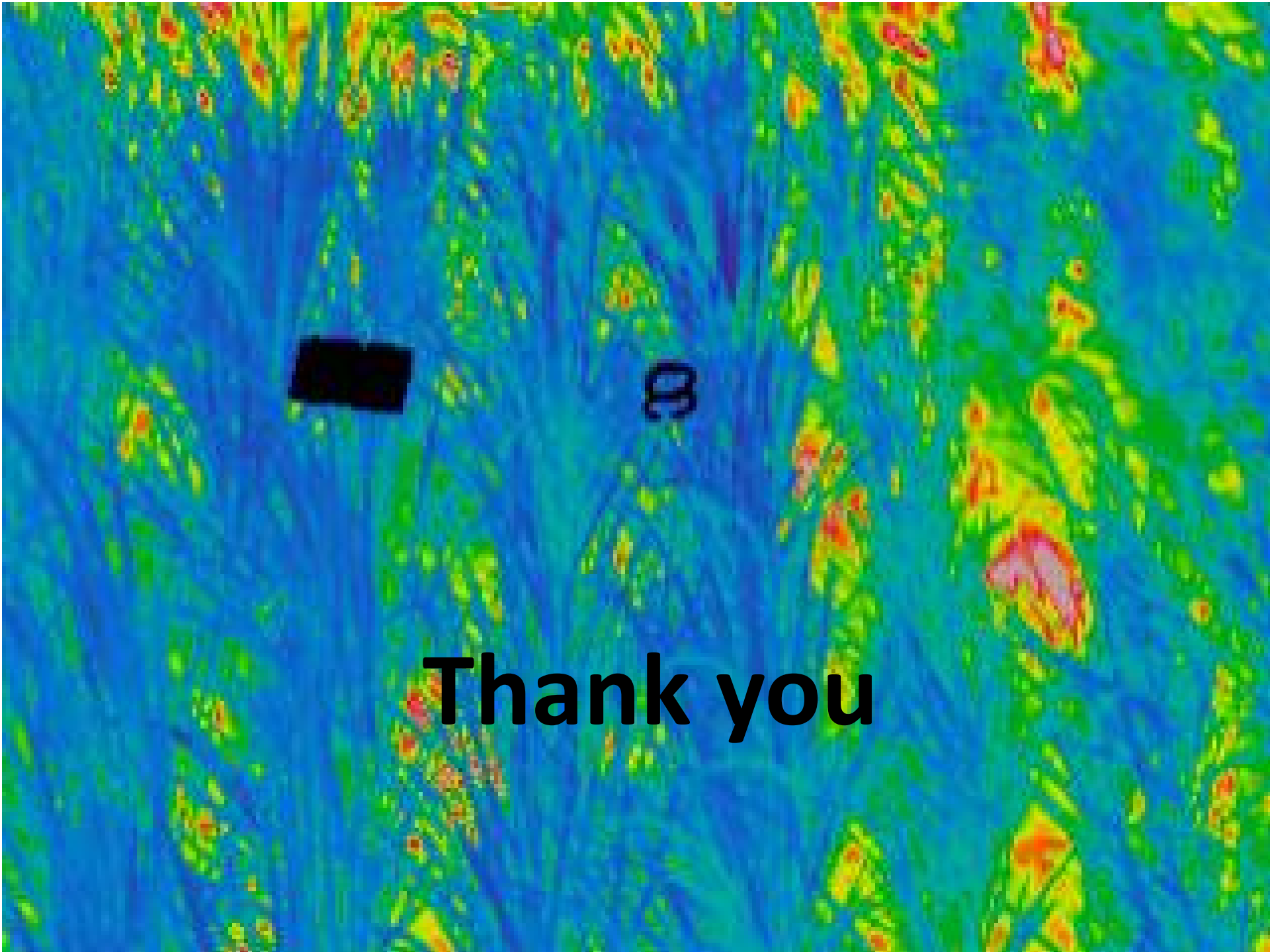

CWSI
1,0
0,8
0,6
0,4
0,2
0,0
-0,2
-0,4
-29,5
-29,0
-28,5
-28,0
-27,5
-27,0
-26,5
-26,0
-25,5
ΔC13 %


Canopy temperature (°C)
40
38
36
34
32
30
28
26
-29,5
-29,0
-28,5
-28,0
-27,5
-27,0
-26,5
-26,0
-25,5
ΔC13 %

Conclusions

- The phenotyping was done (vegetative stage)
- The use of the CWSI allows to compare cultivars between them during the phenotyping time
- Good diversity is observed for transpiration and CID
- Association study will be done further with SNPs
- Phenotyping at reproductive stage
  - With adapted sowing date

- But no correlation between Delta (ΔC13) and other parameter (TC and CWSI)


Thank you